

A Revised Version of the HCM 2010 Urban Streets Automobile LOS Methodology

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ABSTRACT

The Highway Capacity Manual (HCM) 2010 contains a significantly revised automobile analysis and level of service (LOS) methodology for arterials. This paper compared the arterial LOS results of the HCM 2000 and 2010 methodologies for an experimental set of arterial segments and analyzed the effects of the revised methodology. In addition, existing Florida field data sets were also analyzed with arterial segments obtained from Gainesville, Tallahassee, and Tampa, as well as data received from FDOT Districts 2 and 3.

The HCM 2010 results showed that for shorter/lower speed arterial segments (such as in central business districts) it was not possible to obtain LOS A or B. Thus, many of the CBD arterials that had good LOS values under the HCM 2000 methodology would now have moderate to poor LOS values. Consequently, the research team tested several different revisions of the HCM 2010 methodology to find an approach that would not be as punitive to arterials with shorter segment lengths and provide a good balance of LOS values across a range of segment lengths, posted speeds, and traffic demands. Suggested revisions to the HCM 2010 methodology that allowed this objective to be achieved consist of the following: using two-classes instead of one (based on posted speed), using average travel speed as the service measure instead of the ratio of average travel speed to base free-flow speed, and setting free-flow speed equal to the posted speed plus five miles per hour instead of the free-flow speed computations in the HCM 2010 methodology.

INTRODUCTION

The National Cooperative Highway Research Program (NCHRP) Projects 3-70 [1] and 3-79 [2] resulted in the development of level of service (LOS) methodologies for the automobile, bicycle, pedestrian, and transit modes on urban streets. These methodologies were ultimately incorporated into the Highway Capacity Manual (HCM) 2010.

With a particularly strong interest in the arterial multimodal analysis techniques, the Florida Department of Transportation (FDOT) wanted to examine in detail the impacts of the new HCM 2010 methodologies on their LOS program. FDOT sponsored two projects, “Multimodal Arterial LOS Modeling and Testing” [3], in which the multimodal LOS models resulting from NCHRP Project 3-70 were tested in four Florida cities and the results evaluated by a panel of traffic engineers and planners, and “Arterial Highway Capacity and Level of Service Analysis for Florida” [4], both of which, particularly the latter, contributed to this paper.

The objectives of this study were to analyze the differences between the HCM 2000 [5] and HCM 2010 [6] LOS methodologies and determine the appropriate number of arterial classes, service measure, and corresponding LOS thresholds for the automobile, bicycle, and pedestrian modes to meet the arterial LOS analysis needs for FDOT. This paper documents only the automobile mode results, however; the full project reports [3, 4] include the details for all modes.

OVERVIEW of HCM METHODOLOGIES

A brief summary of the differences between the HCM 2000 and HCM 2010 arterial automobile LOS methodologies is given in this section.

HCM 2000

The arterial LOS determination for the HCM 2000 methodology consisted of LOS being based on the average through vehicle travel speed for the facility. This average travel speed was computed from the running times on the arterial and the control delay at signalized intersections. Arterial segment running time values were simply a function of free-flow speed and signal spacing.

Table 1 lists the arterial LOS criteria based on average travel speed and arterial class. The street classifications were generally identified by free flow speed (FFS), as can be seen from the typical FFS values given for each class.

Table 1. HCM 2000 Urban Street LOS Criteria

Urban Street Class	I	II	III	IV
Range of free-flow speeds (FFS)	55 to 45 mi/h	45 to 35 mi/h	35 to 30 mi/h	35 to 25 mi/h
Typical FFS	50 mi/h	40 mi/h	35 mi/h	30 mi/h
LOS	Average Travel Speed (mi/h)			
A	> 42	> 35	> 30	> 25
B	> 34-42	> 28-35	> 24-30	> 19-25
C	> 27-34	> 22-28	> 18-24	> 13-19
D	> 21-27	> 17-22	> 14-18	> 9-13
E	> 16-21	> 13-17	> 10-14	> 7-9
F	≤ 16	≤ 13	≤ 10	≤ 7

Source: HCM 2000, Exhibit 15-2

HCM 2010

The HCM 2010 methodology to determine arterial LOS was based on the results of the NCHRP Project 3-79 [2]. Conceptually, the methodology is largely the same as the HCM 2000 methodology; that is, the LOS is still a function of through vehicle speed. However, the determination of arterial segment running time is now a function of many variables and a more involved calculation procedure.

As seen in Table 1, the HCM 2000 methodology for the determination of arterial LOS was based on four arterial classes, whereas in the HCM 2010 methodology, there is no distinction in the LOS criteria by class. The primary service measure for this methodology is the ratio of average travel speed to base free flow speed (BFFS), as shown in Table 2.

Table 2. HCM 2010 Urban Street LOS Criteria

Travel Speed as a Percentage of Base Free-Flow Speed (%)	LOS by Critical Volume-to-Capacity Ratio
	≤ 1.0
> 85	A
> 67-85	B
> 50-67	C
> 40-50	D
> 30-40	E
≤ 30	F
Note: The critical volume-to-capacity ratio is based on consideration of the through movement volume-to-capacity ratio at each boundary intersection in the subject direction of travel. The critical volume-to-capacity ratio is the largest ratio of those considered. Whenever $v/c > 1.0$, the corresponding LOS is F.	

Source: HCM 2010, Exhibits 16-4 and 17-1

In addition, unlike the HCM 2000, in the HCM 2010 there is a new calculation methodology for BFFS, which states that BFFS is a function of a speed constant (calculated based on the posted speed of the segment), cross section adjustment factor (calculated based on proportions of restricted median and curb on the segment) and an access point adjustment factor (calculated based on number of access point on the segment and segment length).

Also, the revised FFS calculation in the HCM 2010 consists of multiplying this new BFFS value with a signal spacing adjustment factor. This signal spacing adjustment factor is a function of BFFS and segment length. Once the FFS is obtained, the running time is calculated as well as the average travel speed (ATS). Then, the HCM 2010 LOS is obtained by dividing ATS by BFFS and comparing the resultant value to the values shown in Table 2.

It should also be noted that the HCM 2010 LOS thresholds used for ATS/BFFS are generally representative of the ATS divided by FFS values from Exhibit 15-2 of the HCM 2000.

Preliminary Testing

Preliminary automobile LOS testing with the new HCM 2010 urban streets analysis methodology indicated that shorter arterial segments, those that are typically found in a CBD, would result in a poorer LOS than with the HCM 2000 methodology. FDOT felt that this trend of consistently poorer LOS values for CBD arterials under the HCM 2010 methodology was not reasonable and would not be well received by government agencies, practitioners, or developers.

The difficulty of obtaining a good LOS for low speed, short arterial segments under the HCM 2010 methodology is illustrated next.

The HCM 2000 and HCM 2010 methodologies were applied to a two-lane arterial segment of 660 ft with a v/c ratio of 0.90 and posted speed of 35 mi/h, and other inputs set to typical values. Under the HCM 2000 methodology the average travel speed was 13.18 mi/h which resulted in LOS values of LOS C. Under the HCM 2010 methodology, the average travel speed and base free flow speed were 11.61 mi/h and 40.33 mi/h, respectively. This results in an ATS/BFFS value of 0.288 and an LOS of F.

It should be noted that in the HCM 2000 methodology there was no distinction between BFFS and FFS; however, this is no longer true in the HCM 2010 methodology since as mentioned under the HCM 2010 section, FFS is obtained by multiplying BFFS by a signal spacing adjustment factor. After the calculations, it was observed that the HCM 2010 BFFS was always higher than the posted speed for lower posted speed segments, whereas this was not always the case for higher posted speeds. Similarly, the HCM 2010 FFS values were also found to follow this trend. In addition, it was observed that both HCM 2010 BFFS and FFS ranges increase in magnitude as the arterial segment length increases.

The reason why these BFFS and FFS values were found to follow this trend can be explained by the following equations in the HCM 2010 methodology:

$$\text{Speed Constant} = 25.6 + 0.47 \times \text{Posted Speed} \quad (1)$$

$$\text{BFFS} = \text{SpeedConstant} + \text{CrossSectAdjFact} + \text{AccessPtAdj} \quad (2)$$

$$\text{FFS} = \text{BaseFreeFlowSpd} \times \text{SignalSpacingAdjFact} \quad (3)$$

where Speed Constant, Posted Speed, BFFS, and FFS are in mi/h.

As observed in Equation 1, for lower posted speed segments the speed constant value will be higher than the posted speed since the constant term in equation 1 is 25.6 mi/h and the coefficient for the posted speed variable is nearly 0.5. Consequently, this results in BFFS and FFS values larger than the posted speed for lower posted speed arterial segments, as calculated in Equations 2 and 3. Conversely, the BFFS and FFS values will be lower than the posted speed for higher posted speed segments.

In addition, through preliminary testing, it was determined that at least two arterial classes would be necessary in the determination of LOS to meet the FDOT objectives, although this would be verified through the more comprehensive analysis of the least squares method and overall LOS distribution.

RESEARCH APPROACH

The general research approach used in this study was to initially calculate the HCM 2000 and 2010 arterial LOS values for a set of experimental segments. Once the LOS values were obtained, a comparison was made of the differences between the two sets of results. The HCM 2010 methodology was then revised to include a two class arterial classification scheme with threshold values calculated in ATS (mi/h). The revised LOS values that were calculated using this revised LOS methodology were then compared to the LOS values calculated with the HCM 2000 methodology. Two objectives were used to determine the appropriate number of arterial classes and corresponding LOS thresholds: 1) minimize the LOS differences; 2) achieve a relatively balanced distribution of LOS values.

The first step was to minimize the overall number of differences in the LOS values between the HCM 2000 and revised LOS methodologies, by adjusting the thresholds for the specified number of arterial classes, through a least squares method. However, simply minimizing the LOS differences does not necessarily lead to a balanced distribution of LOS values across the full LOS range. Therefore, a set of arterial LOS threshold values that would achieve a low least squares value while maintaining a balanced LOS distribution among the experimental arterial segments was sought.

Input Data

In order to analyze the LOS scores for both HCM 2010 and HCM 2000, hypothetical arterial segments were generated. It was determined that multiple speeds and multiple segment lengths would need to be used for this analysis in order to cover a wide spectrum of real arterial configurations. Since both high- and low-speed arterials should be included in the analysis, posted speeds of 50, 45, 40, 35, 30, and 25 mi/h were used. Similarly, since both high and low arterial segment lengths should be included in the analysis, segment lengths of 660, 990, 1320, 1980, 2640, 5280 and 7920 ft were used.

In addition, in order to replicate the light to heavy congestion during the peak period v/c ratios of 0.99, 0.97, 0.90, 0.83, 0.75, and 0.67 were used. Furthermore, the project team determined that these scenarios should also be generated for both one lane in each direction (N=1) and two lanes in each direction (N=2) conditions. Some of the segments in the full data set represented highly unlikely combinations of variables for real-world arterials (e.g., 660-ft arterial segment length with a posted speed of 50 mi/h). Therefore, for the final analysis a restricted data set was utilized. It was decided that the restricted data set should exclude segments comprised of the 660-990 ft / 50-45-40 mi/h and 5280-7920 ft. / 35-30-25 mi/h length and speed combinations. The input values that were used to construct the experimental arterial segments data set are shown in Table 3.

Table 3. Input Constants for Hypothetical Arterial Segments

Volume to Capacity Ratio (v/c)		0.99, 0.97, 0.90, 0.83, 0.75, 0.67
Cycle Length (C)		120 seconds
Green Time over Cycle Length (g/C)		0.44
Arrival Type		
660 ft and 990 ft		AT-5
1320 ft, 1980 ft and 2640 ft		AT-4
5280 ft and 7920 ft		AT-3
Signal Actuation		
660 ft and 990 ft		Semi-actuated
1320 ft, 1980 ft and 2640 ft		Semi-actuated
5280 ft and 7920 ft		Fully-actuated
Arterial Class		
50 and 45 mi/h segments		Class 1
40 mi/h segments		Class 2
35 and 30 mi/h segments		Class 3
25 mi/h segments		Class 4
% Left turn		10%
% Right turn		10%
Exclusive Left Turn Lane		Yes
Width of Intersection		Varies per Area Type (24, 36 or 60 ft)
K		0.095
D		0.55
PHF		0.925
Percent Heavy Vehicle (HV %)		5%
Start-up Lost Time		2.5 seconds
Access Points in Subject Direction		Varies per Link Length
Access Points in Opposing Direction		Varies per Link Length
Proportion of Segment Length with Median		Varies per Area Type (0 or 1.0)
Proportion of Segment Length with Right Side Curb		Varies per Area Type (0, 0.5 or 1.0)
Area Type		
660 ft and 990 ft		Large Urbanized
1320 ft, 1980 ft and 2640 ft		Urbanized
5280 ft		Transitioning
7920 ft		Rural
Median Type	(N=1)	None (all segment lengths)
	(N=2)	Non-Restrictive (660, 990), Restrictive (≥ 1320)

Experimental Data Set LOS Analysis

For the LOS analysis of the experimental data set, ARTPLAN, a software program that FDOT uses for its arterial LOS analysis purposes, was utilized. This program is generally faithful to the HCM calculations, but makes extensive use of default values representative of Florida conditions, which can always be changed by the user. ARTPLAN was modified accordingly, by its author Scott Washburn, to perform the alternative LOS methodologies being tested.

For analysis purposes, the letter grading of the LOS values obtained were converted to a numbering scheme, with LOS A = 1, LOS B = 2, LOS C = 3, LOS D = 4, LOS E = 5 and LOS F = 6. After all of the above mentioned input constants for the hypothetical arterial segments were determined, the revised version of ARTPLAN was used to calculate BFFS in mi/h, FFS in mi/h, ATS in mi/h, ATS as percent of BFFS, and the corresponding LOS value per the current HCM 2010 methodology.

Once this calculation was performed for N=1 for posted speeds of 50, 45, 40, 35, 30, and 25 mi/h for each different segment length of 660, 990, 1320, 1980, 2640, 5280 and 7920 ft, it was repeated for N=2 as well. As mentioned earlier, the HCM 2010 service measure for arterials is ATS/BFFS. The threshold values given in Table 2 were suggested by the NCHRP Project 3-79 [2] research team and accepted by the Highway Capacity and Quality of Service Committee (HCQSC) to be incorporated into the HCM 2010.

ANALYSIS AND RESULTS

The initial task for the analysis portion of the study was to fully explore the potential trend of disproportionately more poor LOS values for shorter segments than for longer segments. This process is described in the following section.

Evaluation of the HCM 2010 Methodology with the Experimental Data Set

The HCM 2010 results were determined for all the segments of the experimental data set. The distribution of LOS values across all 360 segments is shown in the second column of Table 4. As can be seen, a relatively balanced distribution of LOS values is present, although no segments had an LOS of A. However, when focusing on only short, low-speed CBD segments, it was

observed that out of the 72 CBD test segments, only 1 segment achieved an LOS value of C or better as seen in the third column of Table 4.

Table 4. Overall and CBD Arterial Segments HCM 2010 LOS Distribution Summary

LOS	Overall Segments	CBD Segments	% CBD Segments to Overall Segments
LOS A	0	0	0.00
LOS B	39	0	0.00
LOS C	103	1	0.97
LOS D	115	22	19.1
LOS E	92	41	44.6
LOS F	11	8	72.7
TOTAL	360	72	20.0

It could be observed from the percent CBD segment to overall segments column of Table 4 that the segment percentages of LOS E and F were much higher than that of LOS C and D. This meant that CBD segments mainly resulted in LOS E and LOS F values regardless of their respective v/c ratios (assuming at least moderate traffic demands during a peak period) and posted speeds. Thus, it was confirmed that with the HCM 2010 methodology, it is much more difficult to obtain a good LOS value for shorter segments than for longer segments.

Initial Alternative LOS Methodology

The first task performed towards trying to identify an LOS methodology (arterial classification method, service measure, and LOS thresholds), was to calculate HCM 2000 and HCM 2010 ATS values, the HCM 2010 BFFS values, the HCM 2010 ATS/BFFS values and the HCM 2000 and 2010 LOS values for all of the experimental data segments. As it relates to arterial classification, following the lead of the HCM 2010 to reduce the number of arterial classes, it was desired to use the fewest number of classes that would meet the needs for the FDOT LOS program. Therefore, two classes were initially chosen as the starting point since it was already determined during preliminary analysis that just a single class was not sufficient. The next step was to choose a service measure and identify appropriate LOS threshold values for the two arterial classes.

Arterial classification was initially based on segment length (average segment lengths > 2000 ft are designated as FDOT Class 1; average segment lengths \leq 2000 ft are designated as FDOT Class 2) due to preliminary analysis results suggesting that shorter segment lengths were at a disadvantage in the HCM 2010 methodology.

The primary objective in selecting the service measure and LOS threshold values was to obtain LOS results that were as consistent as possible with the LOS results based on the HCM 2000 criteria. The initially chosen service measure was ATS/BFFS, as this was consistent with the HCM 2010 methodology. To arrive at the initial threshold values, the HCM 2000 ATS LOS threshold values were divided by the assumed FFS value of the corresponding arterial class¹. This resulted in four sets of threshold values since there are four arterial classifications defined in the HCM 2000.

To obtain only two sets of threshold values, the values for classes 1 and 2 were averaged for the new proposed class 1, and the values for classes 3 and 4 were averaged for the new proposed class 2, as shown in Table 5.

Table 5. LOS 2000 threshold values averaged for two classes

LOS	FDOT Class 1	FDOT Class 2
	ATS/BFFS	
A	0.86	0.85
B	0.69	0.66
C	0.55	0.47
D	0.42	0.35
E	0.32	0.26

Using the threshold values that are shown in Table 5, the LOS (hereafter referred to as “Revised LOS 2010”) was determined for all of the experimental data set segments. In this effort, consistency between the HCM 2000 LOS values and the Revised LOS 2010 values was evaluated with a least squares analysis procedure. That is, the difference in LOS for each segment was calculated (by converting the LOS letter to a numeric value; 1 for A, 6 for F) and then this value was squared (i.e., $[\text{LOS HCM 2000} - \text{Revised LOS 2010}]^2$). Squaring of the

¹ The HCM 2000 arterial LOS methodology does not recognize or make use of a base free-flow speed. Thus, for purposes of comparison to the HCM 2010 methodology, whose LOS thresholds are based on the average travel speed/base free-flow speed ratio, free-flow speed in the HCM 2000 methodology is assumed to be equal to base free-flow speed.

differences weighs more heavily the segments with LOS values that differ by more than one LOS grade. The total consistency measure is then calculated by summing all of the individual squared LOS differences. In order to generate threshold values that provide a greater level of consistency, an optimization was performed in which the threshold values were varied until the “minimum sum of squared LOS differences” value was obtained. For the threshold values in Table 5, the sum of the squared LOS differences was found to be 249 and 35 segments had a multiple level LOS difference.

Also, another criterion besides the least squares method was utilized in the determination of threshold values; that is, a reasonably balanced distribution of LOS values for all arterial classes should result. This is because simply setting the threshold values to minimize the least squares value did not necessarily result in a well-balanced distribution of LOS values across all arterial classes. Likewise, setting the LOS threshold values to obtain a well-balanced distribution of LOS values did not necessarily result in the lowest least squares total. Thus, the approach used was to find a reasonable compromise between the two methods; that is, obtain a reasonable distribution of LOS values while also keeping the least squares value relatively low.

In order to achieve a reasonably balanced LOS distribution, the revised FDOT two class LOS distributions were compared to the HCM 2000 arterial LOS values. This procedure was utilized so that the spread of LOS distribution obtained by the revised LOS procedure can achieve higher and lower LOS values for both classes 1 and 2, therefore counteracting the disadvantage for CBD segments as created by the HCM 2010 approach.

The least squares and LOS distribution balancing methods were then applied to a couple of other candidate segment length breakpoints for the arterial classification. Ultimately, it was found that a segment length breakpoint of 1760 ft (average segment lengths > 1760 ft. are labeled as FDOT Class 1; average segment lengths ≤ 1760 ft. are labeled as FDOT Class 2), and the threshold values shown in Table 6 provided the “best fit” to the HCM 2000 results.

Table 6. Optimized Threshold Values

LOS	ATS (mi/h)	
	FDOT Class 1	FDOT Class 2
A	0.80	0.60
B	0.65	0.45
C	0.50	0.40
D	0.40	0.30
E	0.30	0.20

For the threshold values shown in Table 6 and the 1760 ft arterial classification length breakpoint, the sum of the squared LOS differences was found to be 251 and 19 segments had a multiple level LOS difference. With these threshold values it was possible to have a reasonably low least squares sum while achieving a relatively balanced LOS distribution for both Class 1 and 2 arterials.

However, given that the relationship between FFS and posted speed per the HCM 2010 methodology was considered to be inconsistent with observations from Florida arterials, additional methodologies were tested, such as: one using ATS as the service measure with an HCM 2010 FFS calculation procedure and an arterial classification by segment length; one that uses ATS as the service measure and FFS simply set to Posted Speed + 5 (consistent with historical FDOT practice) and an arterial classification by segment length; and one that uses ATS as the service measure with FFS simply set to Posted Speed + 5 and an arterial classification by posted speed. All of these tested methodologies are discussed in more detail in the final report [4].

Recommended LOS Methodology

This section describes the LOS methodology recommended for FDOT implementation, which was subsequently adopted by FDOT, based on the aforementioned testing. The recommended methodology utilizes an arterial classification by posted speed. Arterials with posted speed values of 40 mi/h and higher are classified as Class 1, whereas posted speed values of 35 mi/h and lower are classified as Class 2. The selected service measure is simply ATS, rather than

ATS divided by BFFS. Additionally, FFS is set to Posted Speed + 5, rather than calculated per the HCM 2010 procedure.

The recommended threshold values that provided the best combination of a low least squares total and good distribution of LOS values for both arterial classes are given in Table 7.

Table 7. Recommended Threshold Values

LOS	ATS (mi/h)	
	FDOT Class 1	FDOT Class 2
A	40	28
B	31	22
C	23	17
D	18	13
E	15	10

For this recommended LOS methodology, the sum of the squared LOS differences for the experimental segments between the Revised LOS and the HCM 2000 scenarios was found to be 161, with 6 segments having a 2-level LOS difference.

Table 8 summarizes the LOS distributions for the HCM 2000 and the recommended LOS methodologies, based on the experimental data set.

Table 8. Comparison of HCM 2000 and Recommended LOS Distributions

HCM 2000 Total	Classes 1&2	Classes 3&4		Recommended LOS Total	Class 1	Class 2
2	2	0	LOS A	2	2	0
56	50	6	LOS B	55	47	8
138	42	96	LOS C	133	54	79
111	49	62	LOS D	114	49	65
49	33	16	LOS E	49	22	27
4	4	0	LOS F	7	6	1
360	180	180	Total	360	180	180

It can be observed from these results that the recommended LOS methodology yields a balanced distribution of LOS values, with 2 segments being able to achieve a LOS A for Class 1 arterials and 8 segments being able to achieve LOS B for Class 2 arterials. In addition, the total LOS distribution of the recommended LOS methodology was found to be very similar to the total

HCM 2000 LOS distribution results obtained by using the “by posted speed” arterial classification. In addition, this recommended LOS methodology provided sensitivity to different speeds in different area types such as rural arterial segments (longer segment length and high posted speed) and urban arterial segments (shorter segment length and low posted speed), and uses an intuitive service measure (ATS). Another advantage of using just ATS for the service measure rather than ATS/BFFS is that for the analyst who wants to assess LOS based strictly on field measurements, they do not have to deal with measuring BFFS, which is not a simple task. Since the 2-class scheme satisfied the objectives of this study, additional tests with more than two arterial classifications were not undertaken.

FIELD DATA TESTING

Once the recommended LOS methodology was finalized, Gainesville, Tallahassee, and Tampa field data (collected as part of one of the FDOT projects [3]) were tested using a revised version of ARTPLAN. In addition, field data were received from FDOT Districts 2 and 3 and also tested with the recommended LOS methodology. The main reason for the field data testing was to confirm the validity of the recommended LOS methodology with a sampling of real arterial data, not just the hypothetical experimental data set segments.

The field data generally consisted of all the signal, roadway, and traffic inputs necessary to run the arterial analysis LOS procedure, for the automobile mode as well as bicycle, pedestrian, and transit modes. More detail on the field data collected can be found in the final reports [3, 4]. A good cross-section of arterial types was represented in the Gainesville, Tallahassee, and Tampa data, and comprised a total of 63 arterial segments. FDOT Districts 2 and 3 supplied the research team with 21 and 26 arterial segments, respectively. The District 2 data were solely within the city of Jacksonville, whereas the District 3 data were across the cities of Pensacola, Lynn Haven, Tallahassee, and Gulf Breeze. Similar to the experimental data set, the field data set LOS results using the recommended LOS methodology were calculated and compared to LOS results obtained using the HCM 2000 methodology. The results for this testing are summarized in Table 9.

Table 9. Data Testing Results – LOS Comparison for HCM 2000 vs. FDOT Revised

DATA SOURCE	Total Segments	HCM 2000 vs. FDOT Revised LOS		Percent Match	
		Matching	Close to Matching	% Match	% Match + Close
Gainesville, Tallahassee, Tampa	63	45	11	71.4%	88.9%
FDOT District 2	21	10	6	47.6%	76.2%
FDOT District 3	26	19	1	73.1%	76.9%

The “Close to Matching” column refers to the segments that have ATS values within ± 1.0 mi/h to the respective LOS thresholds that would make the HCM 2000 and FDOT Revised LOS values match. Once this effect is taken into account, the weighted average “percent match + close” value for all of the analyzed field data was found to be at 83.6%.

Considering the differences between the field data set (representing field conditions) and the experimental data sets (hypothetical arterial segments), the “percent match plus close to matching” scores of above 76 percent for all field sites demonstrates that the recommended LOS methodology provides a reasonable “fit” to the field data as well. Therefore, in addition to the experimental data set results, the field data results were also fairly consistent with the HCM 2000 methodology LOS results. Thus, the field data results support the recommended LOS methodology as developed with the experimental data set.

CONCLUSIONS AND RECOMMENDATIONS

The analysis of the HCM 2000 and 2010 LOS methodology results from a large experimental data set revealed that there were significant differences between the two methodologies. The most significant difference is that shorter/lower speed arterial segments result in consistently poorer LOS values under the HCM 2010 methodology than with the HCM 2000 methodology. This situation was very undesirable for Florida and FDOT, as it would create many complications about achieving LOS standards and its project prioritization program given the large number of arterials in large urban areas that would now be deemed excessively deficient under the HCM 2010 LOS methodology. To rectify this situation, it was decided to revise the HCM 2010 methodology in Florida to the extent that it would yield LOS results fairly consistent

with those obtained from the HCM 2000 methodology across the full spectrum of arterial configurations.

To achieve this objective, the following revisions were made to the HCM 2010 arterial LOS analysis methodology:

- Use two arterial classes instead of one, with posted speed as the classification criterion. Arterials with a posted speed of 40 mi/h or greater are considered Class 1, and arterials with a posted speed of 35 mi/h or lower are considered Class 2.
- Set free-flow speed equal to posted speed plus 5 mi/h, rather than the free-flow calculation procedure.
- Use average travel speed for the service measure instead of average travel speed divided by base free-flow speed.
- Use average travel speed LOS thresholds as shown in Table 7.

Overall, the LOS distribution results that were generated from this revised LOS methodology matched very closely with the HCM 2000 LOS distribution results. It is recommended that FDOT use this revised HCM 2010 arterial LOS methodology if it wants to maintain reasonable consistency in analysis results with the HCM 2000 LOS methodology. The FDOT's historical practice of setting FFS equal to posted speed plus 5 mi/h is based on limited observations, and deviates from the new FFS calculation method in the HCM 2010. Thus, it is also recommended that the FDOT perform a comprehensive study on free-flow speeds along Florida arterials and then readdress the topic of arterial free-flow speed. In 2012 FDOT implemented these recommendations for arterial analyses in Florida.

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